A REPORT ON THE TROPHIC STATUS OF

STAR LAKE

WHITESHELL PROVINCIAL PARK

(1979 - 1982)

By

C. Hughes

Basic Trophic Assessment Sub-Program
Water Standards and Studies Section
Environmental Management Services Branch
Environmental Management Division

Water Standards and Studies 83-7

ACKNOWLEDGEMENT

I would like to express my thanks to Mr. and Mrs. D. Brown and family, and Mr. and Mrs. B. Blunt who collected chlorophyll *a* samples and Secchi disc data from Star Lake.

INTRODUCTION

The Public Participation Program was initiated in 1978 in response to requests for water quality information by concerned cottage owners on many of the recreational lakes in Manitoba. Previous studies have shown that the enrichment (trophic) status of a lake can be estimated by the use of Secchi disc readings (transparency) and chlorophyll a concentrations (the green pigment in algae) which indicate water clarity and algal densities, respectively. The determination of the trophic status of lakes is vital to the classification of those lakes for management purposes, restoration, protection and site specific monitoring.

Volunteers are supplied with sampling kits which include a Secchi disc, a composite water sampler, one litre bottles, magnesium carbonate preservative and instructions. Participants are requested to take weekly Secchi disc measurements and samples during the ice free period of the year. Water samples are preserved and shipped to the Technical Services Laboratory in Winnipeg, where they are analyzed for chlorophyll a. Analyses of the chlorophyll a and Secchi disc results reveal the relative trophic status of each lake. Long term sampling over a number of years is useful in the detection of trends related to nutrient enrichment.

It is essential that a sampling program on a lake be continued over a period of five to ten years in order to determine if there is a trend toward accelerated enrichment. In many lakes, temporary degradation of water quality occurs during periods of extensive algal blooms. The fluctuation in algal populations occurs both seasonally and from year to year, and is caused by environmental factors such as sunlight and chemical and biological activity. Over the long term, however, definite increases in chlorophyll a would be indicative of accelerated enrichment (eutrophication) which could be induced by the addition of man generated nutrients.

Sources of nutrients are sink and laundry wastes and seepage from septic tank systems and pit privies. All lake users should be aware of the potential problems which can be caused by these sources of nutrients and that they can contribute to the impairment of recreational and aesthetic water quality. If, over the long term, it becomes apparent that man generated nutrients are contributing to accelerated eutrophication, then the sources would have to be identified and steps would have to be taken to minimize their effects.

This report includes a map or maps showing stations, weekly chlorophyll a and Secchi disc values, mean annual chlorophyll a and Secchi disc values and trophic state indices. The trophic state indices (0-100), developed by Carlson (1977), are derived from mean annual chlorophyll a and Secchi disc values.

NOTE: Water taken from lakes for domestic uses should be boiled or disinfected and, as is stated in the Public Health Act of Manitoba,

"All surface waters should be considered unsafe for domestic purposes unless boiled or otherwise disinfected..."

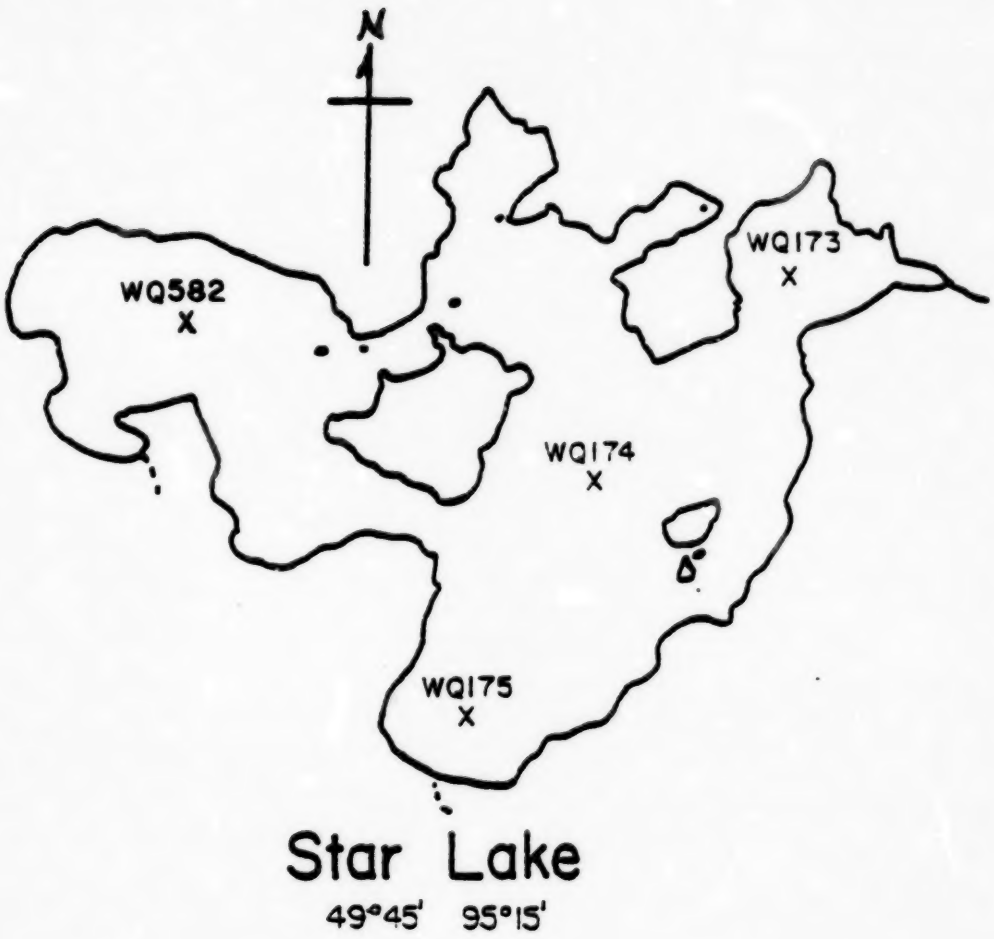

FIGURE 1: Location of Water Quality Stations on Star Lake

RESULTS AND DISCUSSION

Chlorophyll a and Secchi disc data from Star Lake were collected at stations WQ173, WQ174 and WQ175 in 1979 and 1981; station WQ174 in 1980; and stations WQ173, WQ174, WQ175 and WQ582 in 1982 (Figure 1). Chlorophyll a and Secchi disc results are presented for 1978 through 1982 in Table 1.

The mean annual chlorophyll a and Secchi disc results for each station sampled on Star Lake and other Whiteshell Lakes are presented in Table 2 (1979 through 1982). The overall annual mean chlorophyll a in 1979 was relatively high at 12.3 ug/l but decreased to 7.0, 4.5 and 5.5 ug/l in 1980, 1981 and 1982, respectively. The chlorophyll a noted in 1981 and 1982 was indicative of low to moderate algae populations in Star Lake and showed considerable improvement compared to results in 1979 (Figure 2). The overall mean annual Secchi disc results indicate that water transparency fluctuates from year to year. The overall mean Secchi disc results ranged from 2.2 to 2.6 m from 1979 to 1981 and subsequently dropped to 1.8 m in 1982 (Figure 2).

Carlson's (1977) trophic state indices (TSI) for chlorophyll a and Secchi disc have been noted for each station sampled in Star Lake, 1978 through 1982 (Table 2). The TSIs for chlorophyll a and Secchi disc ranged from 44.8 to 55.7 and this would indicate that Star Lake is mesotrophic to eutrophic in character. Subsequent data collection will be required in order to delineate unusual occurrences and document any permanent change in trophic status.

Table 1. Chlorophyll a (Chlor. a in ug/l) and Secchi disc (S.D. in m)values for Station WQ 173, WQ174, WQ175 and WQ582 in Star Lake from 1979 through 1982

Date	Station WQ173		Station WQ174		Station WQ175		Station WQ582	
	Chlor. a (ug/l)	S.D. (m)	Chlor. a (ug/l)	S.D. (m)	Chlor. a (ug/l)	S.D. (m)	Chlor. a (ug/l)	S.D. (m)
1979								
May 14	2.3	2.3	12.5	1.9	3.1	1.9		
May 22	4.0	2.5	2.4	2.5	3.9	2.8		
May 28	4.8	2.0	4.5	2.0	4.2	2.0		
June 4	7.4	2.3	4.1	2.3	4.0	2.5		
June 11	3.1	2.6	1.9	2.6	7.4	2.2		
June 18	12.0	3.7	9.1	3.6	18.5	3.7		
June 25	9.7	2.9	8.9	2.7	8.9	2.7		
July 3	10.2	2.4	16.0	2.3	20.8	2.3	Not sampled	
July 9	9.5	2.8	9.8	2.5	8.4	2.7	in 1979	
July 16	8.3	1.8	12.0	1.6	7.7	1.7		
July 23	18.6	2.0	18.9	1.9	40.9	1.8		
July 30	31.8	1.8	11.5	2.0	16.9	1.8		
Aug. 7	13.4	1.6	12.5	1.9	17.3	1.5		
Aug. 13	16.8	1.7	15.4	1.8	14.3	1.8		
Aug. 20	15.4	1.8	26.0	1.8	21.8	1.8		
Aug. 27	29.4	1.8	22.3	2.0	9.4	1.9		
1980								
May 25			4.8	4.0				
June 1			3.5	2.4				
June 16			3.2	2.4				
June 22			4.8	3.5				
July 1			8.4	2.8				
July 6			4.2	2.8				
July 13	Not Sampled		6.7	2.0	Not Sampled		Not Sampled	
July 20	in 1980		7.1	2.5	in 1980		in 1980	
July 26			4.5	2.5				
Aug. 4			7.5	2.0				
Aug. 25			12.9	1.5				
Sept. 1			12.2	1.7				
Sept. 21			10.4	1.8				
Oct. 13			7.2	1.7				
1981								
May 24	3.5	3.5	2.3	3.2	2.2	3.5		
May 31	3.9	3.5	5.6	3.0	3.5	3.5		
June 7	4.1	3.5	3.8	3.9	3.4	3.2		
June 14	3.0	3.5	3.9	3.8	3.2	2.8		
June 21	2.6	3.8	2.5	3.3	2.6	3.3		
June 28	6.3	2.5	2.4	2.5	3.9	2.8		
July 12	5.9	2.5	5.7	2.5	5.2	2.5	Not Sampled	
July 19	3.2	2.5	3.1	2.2	4.4	2.0	in 1981	
July 26	5.0	1.8	4.7	1.6	4.7	1.7		
Aug. 3	5.7	2.0	6.2	2.0	5.2	2.0		
Aug. 9	3.5	1.8	4.2	2.0	5.2	1.8		
Aug. 23	4.9	2.5	4.7	2.5	5.3	2.5		
Aug. 30	6.2	2.0	6.5	2.0	5.9	2.0		
Sept. 7	8.3	2.0	6.3	2.0	5.7	1.8		
Sept. 20	4.9	2.3	5.1	2.3	3.3	2.5		
1982								
May 16	8.6	2.0	8.8	1.9	6.8	2.0	-	-
May 24	4.1	2.0	2.3	2.0	3.3	1.9	2.0	2.6
May 30	1.5	2.6	1.8	2.4	2.5	2.2	2.2	1.8
June 13	4.1	1.9	3.1	2.0	4.6	1.9	2.1	5.3
June 27	4.8	NA	2.9	NA	4.3	NA	NA	6.0
July 4	2.2	2.2	1.8	2.1	2.5	2.0	2.0	2.4
July 12	3.2	2.1	3.9	1.9	3.9	1.7	2.1	3.3
July 18	2.5	1.8	7.5	1.5	7.5	1.4	1.2	5.0
Aug. 8	6.3	1.5	7.9	1.2	6.7	1.5	1.4	5.8
Aug. 29	6.2	1.5	6.4	1.3	6.4	1.3	1.5	6.5
Sept. 6	10.	1.6	10.	1.4	9.5	1.5	1.6	10.
Sept. 19	10.	1.6	11.	1.5	13.	1.5	1.5	8.3

Table 2. Mean annual Chlorophyll a and Secchi disc values and trophic status index (TSI) for each station sampled on lakes in the Whiteshell Provincial Park, excluding lakes on the Winnipeg River, 1978 through 1980.

Lake	Station	1978				1979				1980			
		Chlorophyll a (ug/l)		Secchi Disc (m)		Chlorophyll a (ug/l)		Secchi Disc (m)		Chlorophyll a (ug/l)		Secchi Disc (m)	
		Mean	TSI*	Mean	TSI*	Mean	TSI*	Mean	TSI*	Mean	TSI*	Mean	TSI*
Barren	WQ577	--	--	--	--	--	--	--	--	--	--	--	--
Betula	WQ020	21.5	60.7	0.9	61.0	19.0	59.4	1.3	56.2	--	--	--	--
	WQ021	23.0	61.3	0.9	61.6	18.8	59.3	1.3	56.2	16.0	57.7	1.2	57.5
	WQ022	22.3	61.0	0.9	61.3	18.4	59.1	1.3	56.0	--	--	--	--
	WQ560	--	--	--	--	--	--	--	--	--	--	--	--
	WQ578	--	--	--	--	--	--	--	--	--	--	--	--
	WQ579	--	--	--	--	--	--	--	--	--	--	--	--
Brereton	WQ031	28.0	63.3	0.7	65.1	18.0	58.9	1.2	57.2	20.2	60.1	1.2	57.1
	WQ032	24.1	61.8	0.8	63.1	18.6	59.3	1.2	57.7	17.7	58.8	1.3	56.6
	WQ033	24.1	61.8	0.8	62.6	18.0	58.9	1.2	56.9	19.7	59.8	1.3	56.7
	WQ547	--	--	--	--	--	--	--	--	17.3	58.5	1.3	56.6
Caddy	WQ039	9.9	53.1	1.4	54.8	16.9	58.3	1.7	52.3	--	--	--	--
	WQ040	11.1	54.2	1.4	55.1	17.5	58.6	1.8	51.8	--	--	--	--
	WQ041	10.4	53.4	1.4	55.0	19.1	59.5	1.7	52.0	11.0	54.1	1.7	52.7
Falcon	WQ061	4.1	44.4	3.8	40.7	8.9	52.0	4.4	38.7	--	--	--	--
	WQ063	--	--	--	--	--	--	--	--	--	--	--	--
	WQ431	3.5	42.8	4.1	39.7	7.0	49.7	4.4	38.7	2.0	37.5	3.4	42.2
	WQ432	3.4	42.6	4.2	39.4	7.9	50.9	4.4	38.5	--	--	--	--
Florence	WQ580	--	--	--	--	--	--	--	--	--	--	--	--
Jessica	WQ065	10.5	53.7	1.3	56.3	15.9	57.7	1.5	54.4	6.6	49.1	1.8	51.4
	WQ066	11.6	54.4	1.3	56.6	14.8	57.0	1.5	54.3	6.3	48.6	1.8	51.8
	WQ067	15.0	57.1	1.2	57.5	15.2	57.3	1.3	56.6	7.7	50.5	1.6	53.1
Marion	WQ581	--	--	--	--	--	--	--	--	--	--	--	--
Red Rock	WQ144	9.7	52.9	2.0	49.9	14.2	57.0	2.2	48.4	20.4	60.1	2.0	50.1
	WQ145	10.3	53.4	1.9	50.9	13.4	56.0	2.1	49.2	--	--	--	--
	WQ146	9.1	52.3	1.7	52.7	14.4	56.7	2.0	49.9	--	--	--	--
Star	WQ173	--	--	--	--	12.3	55.2	2.2	48.4	--	--	--	--
	WQ174	--	--	--	--	11.7	54.7	2.2	48.6	7.0	49.6	2.4	47.4
	WQ175	--	--	--	--	13.0	55.7	2.2	48.3	--	--	--	--
	WQ582	--	--	--	--	--	--	--	--	--	--	--	--
West Hawk	WQ177	2.6	39.8	4.5	38.3	8.2	47.3	5.4	35.8	1.6	35.2	4.9	38.3
	WQ182	2.6	39.8	5.0	36.9	5.4	47.1	6.8	32.4	1.3	33.1	5.5	35.4
	WQ187	2.6	39.7	5.4	35.7	8.2	53.9	6.4	33.1	1.2	32.4	5.5	35.4
	WQ583	--	--	--	--	--	--	--	--	--	--	--	--
White	WQ188	13.0	55.7	1.1	58.9	18.3	59.1	1.3	56.2	9.9	53.0	1.6	53.6
	WQ189	14.8	57.0	1.1	59.0	16.9	58.3	1.4	55.2	9.9	53.0	1.6	53.0
	WQ190	14.5	56.8	1.1	59.2	22.1	60.9	1.3	56.2	10.2	53.4	1.7	52.6
Whiteshell	WQ202	18.7	59.3	1.6	53.0	19.1	59.5	2.6	46.3	19.2	59.5	1.7	52.4
Big	WQ433	19.1	59.5	1.6	53.6	19.9	59.9	2.7	46.0	20.3	60.1	1.6	53.7
	WQ434	18.9	59.3	1.5	54.2	21.3	60.6	2.4	47.5	20.1	60.0	1.5	54.2

* Carlson's (1977) Trophic State Index.
a Less than 5 Samples Taken.

Table 2. Continued

Lake	Station	1981 Chlorophyll a (ug/l) Mean	1981 Chlorophyll a (ug/l) TSI*	1981 Secchi Disc (m) Mean	1981 Secchi Disc (m) TSI*	1982 Chlorophyll a (ug/l) Mean	1982 Chlorophyll a (ug/l) TSI*	1982 Secchi Disc (m) Mean	1982 Secchi Disc (m) TSI*
Barron	WQ577	29.6	63.8	0.8	56.8	---	--	--	--
Betula	WQ020	7.0	49.7	0.7	64.7	10.9	54.0	1.5	53.9
	WQ021	9.4	52.6	1.0	60.3	--	--	--	--
	WQ022	8.1[a]	51.1[a]	2.0[a]	50.0[a]	11.3	54.4	1.5	54.3
	WQ560	8.1	51.0	0.7	64.6	--	--	--	--
	WQ578	--	--	--	--	10.0	53.2	1.5	54.4
	WQ579	--	--	--	--	11.4	54.4	1.5	54.0
Broraton	WQ031	8.1	51.1	1.0	60.1	3.3	42.2	1.3	55.8
	WQ032	11.3	54.3	1.3	55.8	7.5	50.4	1.1	56.0
	WQ033	11.5	54.5	1.4	55.3	8.5	51.6	1.2	57.1
	WQ547	--	--	--	--	--	--	--	--
Caddy	WQ039	4.8	46.0	2.2	48.9	6.5	49.0	1.6	53.1
	WQ040	5.2	46.6	1.7	52.5	6.6	49.1	1.5	53.9
	WQ041	5.1	46.5	1.9	51.0	6.0	48.2	1.5	54.6
Falcon	WQ061	2.7	39.6	3.8	40.7	3.0	41.2	4.5	38.4
	WQ063	--	--	--	--	2.7	40.2	3.8	40.7
	WQ431	2.7	40.3	3.8	40.7	2.6	39.8	3.6	41.4
	WQ432	--	--	--	--	--	--	--	--
Florence	WQ580	2.8	40.6	2.6	46.2	2.9[a]	41.0[a]	2.6[a]	46.5[a]
Jessica	WQ065	7.1	49.8	1.2	57.3	10.4	53.5	1.0	60.7
	WQ066	6.6	49.0	1.3	56.6	9.0	52.1	1.0	60.5
	WQ067	23.4	61.5	1.6	53.6	9.6	52.8	0.9	60.9
Marion	WQ581	20[a]	37.1[a]	4.9[a]	37.2[a]	1.8[a]	36.3[a]	3.5[a]	42.1[a]
Red Rock	WQ144	12.4	55.3	2.2	48.4	5.8	47.8	2.4	47.5
	WQ145	4.7	45.8	1.9	50.8	4.9	46.2	2.1	49.6
	WQ146	--	--	--	--	--	--	--	--
Star	WQ173	4.7	45.8	2.6	46.1	5.3	46.9	1.9	50.9
	WQ174	4.5	45.3	2.6	46.3	5.6	47.5	1.7	52.0
	WQ175	4.3	44.8	2.6	46.3	5.9	48.0	1.7	52.2
	WQ582	--	--	--	--	5.3	46.9	1.8	51.8
West Hawk	WQ177	2.2	38.2	3.9	40.4	1.6	35.2	3.7	41.3
	WQ182	2.0	37.4	5.3	36.0	1.3	33.4	4.9	37.1
	WQ187	2.1	38.0	4.9	37.0	1.5	34.8	4.5	38.3
	WQ583	--	--	--	--	1.8[a]	36.5[a]	4.8[a]	37.3[a]
White	WQ188	--	--	--	--	4.9[a]	45.5	1.0[a]	60.0[a]
	WQ189	8.2	51.3	1.3	56.4	11.4	54.5	1.2	56.9
	WQ190	8.0	50.9	1.4	55.0	--	--	--	--
Whiteshell	WQ202	22.6	61.2	1.7	52.2	25.4[a]	62.3[a]	1.3[a]	56.6[a]
Big	WQ433	20.1	60.0	1.7	52.3	23.9	61.7	1.2	56.9
	WQ434	15.8	57.6	1.6	52.9	23.9	61.7	1.0	60.7

* Carlson's (1977) Trophic State Index.
a Less than 5 Samples Taken.

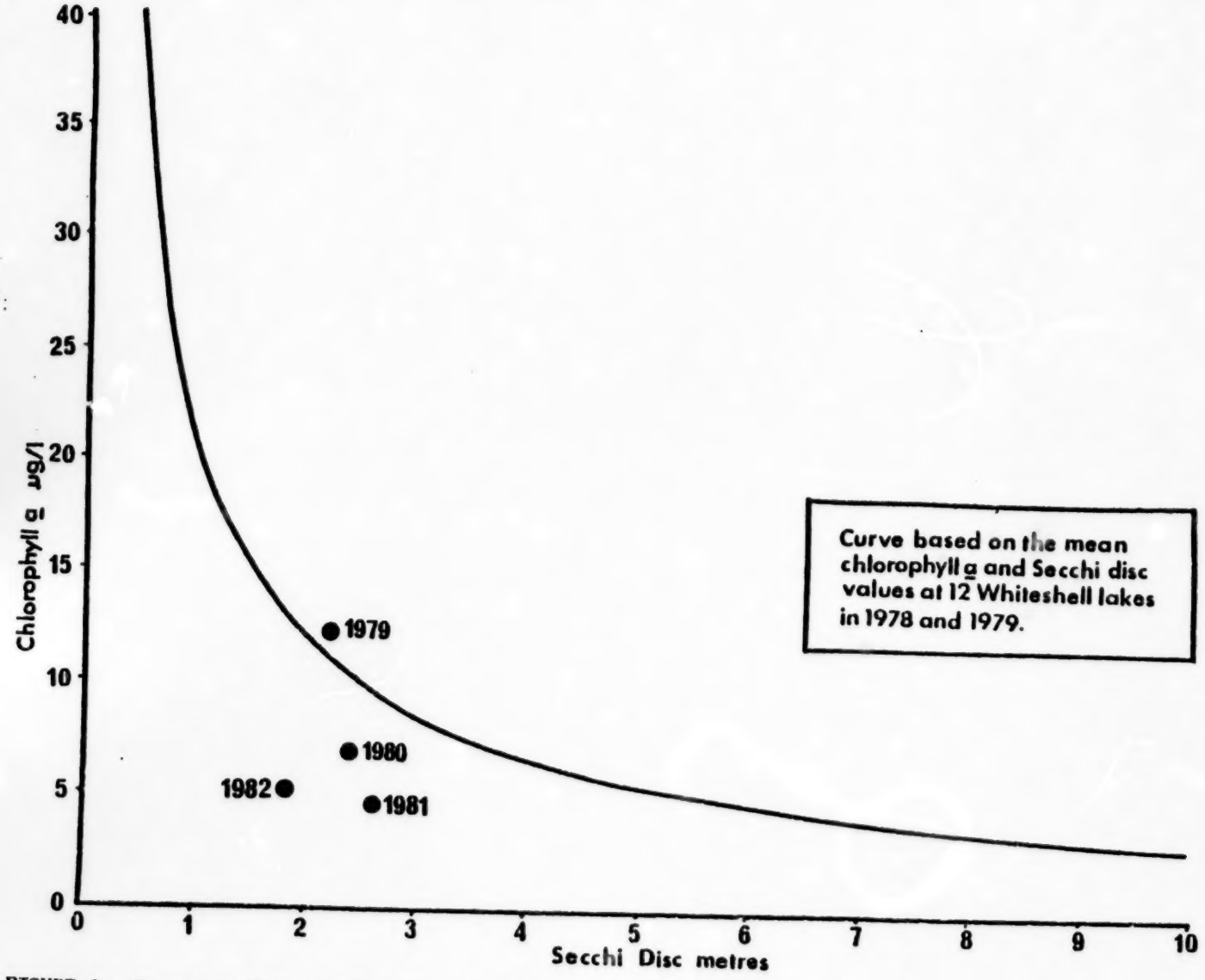

FIGURE 2: The Mean Chlorophyll a and Secchi Disc Values Collected on Star Lake

GLOSSARY OF TERMS

ALGAE - an assemblage of simple, mostly microscopic non-vascular plants containing photosynthetic pigments such as chlorophyll. Algae occur suspended in water (phytoplankton) and attached to rock and other suitable substrates. Some algae may produce nuisance conditions when environmental parameters are suitable for prolific growth.

CHLOROPHYLL - the photosynthetic green pigment which occurs in all groups of algae.

EUPHOTIC ZONE - the lighted region that extends vertically from the water surface to the level at which photosynthesis fails to occur due to insufficient light penetration.

EUTROPHIC - waters containing a rich supply of plant nutrients that support heavy growths of algae and aquatic plants. The increase in algae causes a decrease in the penetration of light. Deep areas may exhibit oxygen depletion due to the decomposition of dead organisms. Eutrophic lakes tend to be shallow and support warm water species of fish. The degradation in water quality renders the lake unsuitable for many recreational activities.

EUTROPHICATION - the process of becoming increasingly enriched in nutrients. It refers to the entire complex of changes which accompanies increasing nutrient enrichment. The result is the production of dense nuisance growths of algae and aquatic weeds which generally degrade water quality and render the lake unsuitable for many recreational activities. Accompanying the increase in algae is a decrease in game fish and an increase in coarse fish.

MESOTROPHIC - waters characterized by a moderate nutrient supply and organic production (i.e. midway between eutrophic and oligotrophic). The waters are suitable for most recreational activities.

OLIGOTROPHIC - waters containing a poor supply of plant nutrients resulting in little algae and aquatic plant growth. The waters are generally clear permitting extensive light penetration. Oxygen in the bottom waters is abundant. Oligotrophic lakes tend to be deep and support cold water fish such as lake trout and whitefish. The lakes are well suited for all types of recreational activities.

SECCHI DISC - a circular metal plate, 20 centimeters in diameter, the upper surface of which is divided into four equal quadrants and so painted that two quadrants directly opposite each other are painted black and the intervening ones white. The Secchi disc is used to estimate the depth of the euphotic zone.

TROPHIC STATUS - depending upon the degree of nutrient enrichment and resulting biological productivity, lakes are generally classified into three intergrading types: oligotrophic, mesotrophic and eutrophic. If the supply of nutrients to an oligotrophic lake is progessively increased, the lakes becomes more mesotrophic in character; with continued enrichment, it will become eutrophic.

µg/l - micrograms per liter or parts per billion.

LITERATURE CITED

CARLSON, R. E. 1977. A trophic state index for lakes. Limnol. Oceanogr. 22(2): 361-369.

Province of Manitoba. 1981. Public Health Act. Revised Regulations P210-R3, Division VII, Section 57.

POOR

QUALITY

ORIGINAL